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## SPECULATIVE BIOLOGY.

*Les Problèmes de la Vie. Essai d'une interprétation scientifique de phénomènes vitaux.* I<sup>e</sup> Partie. *La Substance Vivante et la cytodierèse.* By Dr. Ermanno Giglio-Tos, of the University of Turin. Pp. viii+286. Thirty-three figures. (Turin: Chez l'auteur, Palais Carignano, 1900.) Price, 10 francs.

AT a time when many, if not most, biologists are confessing that they find no helpful analogy between the operations of not-living matter and the adaptive and coordinating activities of the living organism, it is interesting to find one who maintains that vital phenomena are much simpler than they seem. It is maintained in the book before us that we have invested with a veil of mystery what are really "the natural consequences of chemical, physical and mechanical phenomena." This has been a frequently recurrent idea in the history of biology; but the author has worked it out in a theoretical system in which biomolecules and biomores, bioplasm and biomonads play a part supposed to be comparable to that of atoms and molecules and radicals in chemistry.

The fundamental facts of life with which Dr. Giglio-Tos begins his materialistic reconstruction of biology are assimilation and reproduction. In assimilation, the organism adds to its own organisation at the expense of material different from itself; in reproduction, it gives rise to other units which are actually or potentially like itself. These processes of growth and multiplication may seem simple in words, but whenever we pass to the things themselves they impress us as marvellous, even in simple creatures like amœba or diatom, monad or microbe, coccidian or myxomycete. And the impression of marvellous complexity, in spite of apparent simplicity, is heightened whenever the organisms show, as they so often do, some evidence of "behaviour" (whether it be chemotactic attraction and repulsion or adaptive and co-ordinated movements in search of food). But by dwelling on this "behaviour," which seemed to us of the very essence of life, we have become blind—so this book suggests—to the real simplicity of the assimilative and reproductive processes, which are "truly and exclusively chemical." To prove this last statement directly is not at present possible, for we do not know the chemical composition of living matter; but what the author proposes is the legitimate and practicable test—Are the interpretative formulæ of the chemist sufficient for a simpler re-description of vital phenomena? His answer is an emphatic affirmative. To be convinced, we are invited to make a simple experiment, in regard to which a chemist's opinion would be of much interest. We are told to "feed" two molecules of acetic acid with perchloride of phosphorus; and the resulting chloride of acetyl with zinc-ethyl; we are asked to subject the resulting methyl-ethyl-ketone to oxidation; and the result is that from two molecules of acetic acid we get four.

"May we not say that the two molecules of acetic acid have assimilated and reproduced? . . . Reproduction is the fission of a living molecule ('biomolecule'), which,

after a series of assimilatory reactions, divides into other molecules of the original constitution."

We do not ourselves find any cogent evidence to show that a living molecule or biomolecule exists, or that it is needed as a theoretical postulate in biological interpretation; it seems to us highly probable that living matter is a complex mixture (organisation or synthesis) of organic substances whose virtue is in their inter-relations; we do not see in the acetic acid story more than an analogy of very doubtful suggestiveness. But we must let the author tell his own tale. He devotes his second chapter to mapping out the possible developmental cycles of the imaginary biomolecule. Through phases of assimilation, followed by rearrangement of atoms, the biomolecule matures and multiplies, and there are three possible schemes: of (I.) autogenetic, (II.) homogenetic and (III.) heterogenetic development:—

(I.)  $a$  becomes  $b$ , then  $c . . . . d . . . . m$ , which divides into  $a + a$ .

(II.)  $a' . . . . b' . . . . c' . . . . d' . . . . m' = e' + e'$  (and  $e'$  may thereafter give rise to  $a' + a'$ ).

(III.)  $a'' . . . . b'' . . . . c'' . . . . d'' . . . . m'' = e'' + i''$  (of which  $e''$ , called genetic, may regenerate  $a''$ , while  $i''$ , called somatic, cannot).

The third chapter, dealing with the physiology of the biomolecule, discusses at some length the proposition that "respiration is not a process of combustion but of oxidation," and that the formation of  $\text{CO}_2$  is an indirect result, comparable to what occurs when acetic acid acts on isocyanate of ethyl. The author is under a misapprehension when he says that "respiration is generally regarded to-day as a simple combustion . . . an interpretation accepted by almost all biologists." Although we cannot explain *how* the oxygen, as Pflüger said, helps to wind up the vital clock, although we cannot as yet trace the oxygen through its sojourn in the tissues, we have left the false simplicity of the crude combustion theory far behind. In the pages of the book devoted to this subject, and in those dealing with the formation of starch in vegetable cells, the author argues against positions long since abandoned, and makes no new contribution to the problems.

The fourth chapter introduces us to "the biomore," an old acquaintance with a fresh alias, the visible living particle. It is, of course, formed of biomolecules, probably different from one another and juxtaposed like the inorganic molecules in double salts. The life of the biomore is not dependent on its constitution; it lives because it is formed of molecules themselves alive. Nevertheless, the accomplishment of vital functions is facilitated by the juxtaposition of the biomolecules, and by the increase in their instability which thus results. The arrangement of the biomolecules in the biomore depending on their chemical constitution, there is in the biomore, during assimilation, a continual displacement of biomolecules by reason of their chemical changes. Physiologically considered, "the biomore is a veritable mutual symbiosis of biomolecules." Had the author developed the fruitful idea of "symbiosis," he might have been led to the conception of "protoplasm" (=bioplasm) as an organisation of substances not in themselves living, but in virtue of their interrelations giving rise to the phenomena of life.

The next chapter deals with bioplasm and the biomonad—to wit, protoplasm and the cell—another instance of the craze for rechristening. Perhaps a micrococcus or some similar microbe is composed of but one biomore, but such simplicity is rare. Most unicellular organisms consist of diverse biomores living symbiotically in an interbiomoric fluid (water, nutritive substances in solution and products of secretion). The author explains that *bioplasm* includes nucleoplasm as well as cytoplasm, and that it excludes the metaplasm; it is Huxley's protoplasm, in fact. The *biomonad* is a living unity, a symbiotic system of biomores, characterised by the chemical nature of the biomores which form the nucleus; it is a cell, in fact. But while the author emphasises the fact of symbiosis, he does not, as we have said, really appreciate the idea that vitality is an expression of the interrelations of diverse complex substances associated in a particular organisation or synthesis.

"The faculty of living resides in the biomolecules themselves. The biomores are living because they are composed of biomolecules. The bioplasm is living because it is composed of biomores. The cell is living because it consists of bioplasm. . . . The phenomena of life and their possibility are based on the properties of carbon compounds. . . . The essential characteristic of life, reproduction, is fundamentally a phenomenon of molecular fission into two or more equal molecules."

Thus assertion follows assertion, all, to our thinking, "in the air."

The author's interpretation of cell-division, which is the subject of the three final chapters of this volume, may be inferred from what has been already noticed in regard to the process by which four molecules of acetic acid may be produced from two. Assimilation is the indispensable, though not always sufficient, cause of the division; it leads to an orientation of atoms which makes a division of the biomolecule imperative; the division of the biomolecules provokes the division of the biomore, and the division of the biomores provokes the division of the biomonad. How this speculation in any way interprets the actual processes of cell-division we entirely fail to see; but we are not surprised to find the author insisting that the phenomenon of division is independent of the nature of the division-figures. The figures cannot be chemically interpreted, so they do not count for much. They are dependent on the initial disposition of the biomores in the biomonad.

Assimilation leads to doubling of biomolecules, and this to doubling of biomores; the doubling expresses itself as cell-division, because of the particular orientation of the component biomores, which in turn is due to their reciprocal attractions. If this be granted, it is possible to deduce a number of "rational laws of cell-division," which may be verified by observation. The author deduces no fewer than twenty-eight laws, but many of them read more like assertions, while others are certainly not deductions, but statements of observed fact. We must content ourselves with referring to the first three. The first law is that the living parts of the cell have all the same importance in cell-division; the biomores enjoy perfect equality; this is "a natural consequence of the previous interpretation," and, like it, is all in the air.

The second law is "that the divisions of the diverse

parts of the cell are independent of one another," and the third "that the direction of the division of the nucleus is determined by the direction of the division of the cytoplasm." This may seem to the matter-of-fact a contradiction, but the author maintains "that between the cellular body and the nucleus there is at once a complete independence and a close dependence." This is too subtle for our understanding.

Recognising that the phenomena of cell-division, which he has interpreted as "purely and exclusively mechanical," were somewhat "ideal" ("sont naturellement quelque peu idéaux"), the author proceeds to discuss the modifications which the ideal scheme suffers in real life. Perhaps this may prove to be the most useful part of the book, for the author proposes a series of thirteen problems dealing with the influence of the position of the central corpuscles, of gravity, of mechanical obstacles, of pressure, of the cell-membrane, of adjacent cells, and so on (pp. 184-285). We do not propose to discuss these problems, for an appreciation of the author's mode of treatment is quite impossible to those who find themselves compelled to reject his premises. But let us state his general conclusions.

The property of dividing, which characterises living matter, is not due to a special force. It is a consequence of the constitution of living matter and of assimilation, which doubles the number of the parts of the system and may thus lead to the formation of two systems. The force which unites the parts of living substance in a system is the same as that which unites the parts of dead matter. This force is sufficient to explain the phenomena of division. The figures which characterise cell-division are the structural results of the constitution of living matter, and have no importance in the phenomenon, which is purely and exclusively mechanical. As to the direction of the division, it is partly determined by the position of the central corpuscles, but almost wholly by environmental influences in the widest sense.

Let us sum up our impression of this ambitious book. The author abstracts from his consideration of the living organism its most characteristic features of adaptive and coordinated behaviour, and thus gives a false simplicity to the whole problem. He invents a theoretical system of biomolecules, biomores, bioplasm and biomonads, which depends on the postulate that there are biomolecules—a gratuitous assumption, since it is quite as likely that matter exhibiting vital phenomena owes its virtue to the interrelations of a peculiar organisation or synthesis of not-living molecules. From the doubling of a chemical molecule (of acetic acid) he passes, with an entirely inadequate discussion of the magnitude of the step, to the structural division of a cell. In spite of his hypothetical diagrams, his mathematical formulæ and his twenty-eight so-called laws of cell-division, he leaves the problem all unsolved. The use of a hypothetical system is to furnish convenient modes of re-statement in simpler terms, but we cannot find that the system of Dr. Giglio-Tos makes the division of the amoeba under our microscope any more interpretable than it was before. The author is continually combating the assumption of "special forces"—and here we are at one with him—but the neo-vitalists do not believe in vital force. They content themselves with disbelieving that the behaviour

of a living organism is as yet interpretable in terms of the formulæ used by the chemist and the physicist. And we find nothing in this volume to shake this disbelief.

J. A. T.

### A PHILOSOPHER ON EVOLUTION.

*The Limits of Evolution.* By Prof. Howison. Pp. xxvii + 380. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1901.) Price 7s. 6d. net.

THE main argument of the book is clearly summarised in the preface. Nothing has any real existence except mind. There are a number of coexistent minds. All else is but the items of their experience, which they arrange in order for themselves. God is the "fulfilled type of every mind," an ideal to which it is trying to assimilate itself. These minds are citizens of an eternal republic. They have had no origin in time. They have not been created in the sense in which the word is ordinarily understood. They are free: "nothing but their own light and conviction determines their action towards each other and towards God." This freedom is made possible by the substitution of a final for an efficient cause. "Real creation means such an eternal dependence of other souls upon God that the non-existence of God would involve the non-existence of all souls." Evolution is the "movement of things changeable towards the goal of a common ideal," and spirits can "neither be the product of evolution nor in any way subject to evolution," which can only reign in "the incomplete and tentative world of experience."

The first and last essays elaborate the theory, insisting always on the freedom of the will. It is in order to prove that the will is free that our author has established his republic of independent minds. If the mind of an individual man is merely part of the force that permeates the whole universe, it can have no freedom. Pantheism, therefore, must be rejected. Creation, too, in the old sense must be given up; if created, the mind can have no independence. Hence the assumption that it has had no beginning and will have no end. Thus war is declared against the monistic philosophy, according to which body and mind are but different aspects of what is divisible only in thought, and the mind, therefore, as perishable as the body.

Prof. Howison fears that philosophy is tending towards determinism, and this tendency he considers fraught with the gravest danger. No doubt if a man puts his determinism into practice, and, when called upon to act, feels that he is a mere automaton set in motion by influences from without, he is not one who can fill any post where energy and determination are required. We must imagine that our wills are free or we are helpless. Whether we are really free is unimportant. The belief is strong in almost every man, at any rate in almost every European. Most men are content to leave the matter undiscussed, holding that they have a real freedom, however inexplicable and even unthinkable it may be. But Prof. Howison tries to find a philosophic explanation for the belief, and, interesting as his book is, we cannot think that he has been successful.

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Let us first consider his "republic of minds." They exist in a world the existence of which is "incomplete and tentative." Nothing but mind is really existent. We start, then, each of us with our own mind. And how do we become cognisant of the existence of other minds? This can only be through our bodily senses. Yet our bodies are not things really existent. Moreover, we cannot touch, see or hear other men's minds; we only infer their existence from their looking out upon us through their bodily eyes or speaking to us with their bodily vocal organs. Thus the existence of a real world of minds is accepted on the evidence that is obtained for us by mere phenomena. Next as to the free will that Prof. Howison has to offer us. If he reduced the whole universe to unreality except each man's own *ego*, then the mind would move *in vacuo*, not tyrannised over by any external influences. As he himself puts it, the condition of freedom for man is that "the world shall be a world of *phenomena*—states of his own conscious being, organised by his spontaneous conscious life—and not a world of 'things-in-themselves.'" But he does not make other minds mere phenomena.

Any individual mind must, therefore, be influenced from without by the other citizens of the republic of minds. No doubt even under these conditions there may be autonomy: the mind may decide *in accordance with its own character* which influence from without it will allow to prevail with it. The existence of other minds need not destroy autonomy in this sense. But free will, such as this, is quite consistent with the monism which Prof. Howison condemns. It is not the freedom in which the ordinary healthy man has at least a practical belief. He has the feeling that he can transcend his own nature, conquer his weaknesses and bad tendencies and develop other and better tendencies. It may be impossible to explain how he can have such a power. Certainly this book leaves us dependent on our instinctive feeling of freedom.

Next as to our author's view of evolution. Evolution, he insists, cannot explain the origin of life or the origin of mind. But no clear-headed evolutionist holds that evolution can originate. We must assume an underlying force which, through evolution, is variously manipulated and concentrated. As to the ultimate origin of the underlying force, evolution has nothing to say. This much we may concede. But Prof. Howison assumes that, not only mind, but *the individual mind* has existed from eternity, and in this he is unreasonable. The development of certain bodily organs proceeds *pari passu* with the development of mental power. We can trace the gradual evolution of nerve till it culminates in the human brain. We are bound to assume, then, that a particular mind is the product of evolution; like the body, it has been elaborated out of something that preceded evolution. This question is not fairly faced by Prof. Howison. In a footnote (p. 10) he allows that we can trace the upward steps of intellectual development, and there he leaves the matter, assuming as the basis of his dualistic philosophy that the mind of each individual has existed from eternity and has, apparently, been inserted extraneously in the body.

Some of the contradictions involved in his system our author sees and attempts to remove. If each individual